CLAIMS

1) A method intended for continuous detection, at any point of a pipe carrying a multiphase mixture of petroleum fluids, of thermodynamic hydrate formation conditions using a mechanistic hydrodynamic module and an integrated compositional
5   thermodynamic module to define the phase properties, and mass conservation and momentum conservation equations, as well as equations of energy transfer in the mixture are applied, considering that the mixture of fluids is substantially continuously at equilibrium, that the composition of the multiphase mixture is variable all along the pipe and that the mass of each constituent of the mixture is globally defined by a mass
10 conservation equation regardless of its phase state, and the petroleum fluids are lumped together into a limited number of pseudo-components, characterized in that the thermodynamic hydrate formation conditions are detected :

-    by carrying out a particular lumping of the petroleum fluids into pseudo-components so as to isolate the hydrate forming components, with definition for each one of a mass
15 fraction and of a certain number of characteristic physical quantities, and

-    by applying to said modules data relative to these particular fractions so as to determine at any point the hydrate dissociation temperature (Td).

2) A method intended for continuous control of hydrate formation at any point of a pipe carrying a multiphase mixture of petroleum fluids, using a mechanistic
20 hydrodynamic module and an integrated compositional thermodynamic module to define the phase properties, and mass conservation and momentum conservation equations, as well as equations of energy transfer in the mixture are applied, considering that the mixture of fluids is substantially continuously at equilibrium, that the

composition of the multiphase mixture is variable all along the pipe and that the mass of each constituent of the mixture is globally defined by a mass conservation equation regardless of its phase state, and the petroleum fluids are lumped together into a limited number of pseudo-components, characterized in that :

5   a) the thermodynamic hydrate formation conditions are detected by :

- carrying out a particular lumping of the petroleum fluids into pseudo-components so as to isolate the hydrate forming components, with definition for each one of a mass fraction and of a certain number of characteristic physical quantities, and

- by applying to said modules data relative to these particular fractions so as to 10   determine the hydrate dissociation temperature (Td) ;

b) a control device (C) is used to compare the temperature of the petroleum fluids with this dissociation temperature (Td) ; and

c) measures intended to fight hydrate formation are applied under the control of this control device (C).

15   3) A method as claimed in claim 2, characterized in that heating means associated with pipe (1) are used to raise the temperature of the petroleum fluids above the dissociation temperature.

4) A method as claimed in claim 3, characterized in that, pipe (1) being included with at least a second pipe (2, 3) in a tube (T) isolated from the outside medium, second 20   pipe (2, 3) is used for circulation of a warm fluid.

5) A method as claimed in claim 2, characterized in that hydrate inhibitors are injected into pipe (1) under the control of control device (C).

FIGURE 1

Simulation sans étude du risque d'apparition d'hydrates : simulation without hydrate appearance risk study

Simulation avec étude du risque d'apparition d'hydrates : simulation with hydrate appearance risk study

Lumping standard : standard lumping

Lumping avec isolement et identification des formateurs d'hydrates : lumping with isolation and identification of the hydrate forming components

Surveillance hydrates : hydrate monitoring

FIGURE 2

Thermodynamique (calcul de l'équilibre des phases) : thermodynamics (phase equilibrium computation)

Masse des constituants : mass of the constituents

Pression-température-composition-formateurs séparés : pressure-temperature-composition-separated hydrate forming components

Schéma numérique : numerical scheme

Quantité de mouvement du mélange : mixture momentum

Scénario : scenario

Hydrodynamique-glissement-frottement : hydrodynamics-slippage-friction

Calculs finaux : final computations

Flux et termes sources : flows and source terms

calcul d'hydrates : hydrate computation

Température de dissociation à P : dissociation temperature at P

Contrôleur : controller

Diagnostic pour le contrôle : diagnosis for control

FIGURE 3

Mesure (capteur logiciel) : measurement (software sensor)

Calcul de Td par le module d'hydrate à la composition locale : computation of Td by

the module of hydrates at local composition

Contrôleur : controller

Consigne : set value

Actions éventuelles : possible action

Augmenter temp. bundle : increase bundle temperature

Injecter inhibiteurs : inject inhibitors

FIGURES 5 - 13

Nombre de points : number of points

FIGURE 14

Temps : time

Longueur : length

FIGURE 15

Pression : pressure

Température : temperature

Courbe d'hydrates à composition initiale locale : curve of hydrates at local initial

composition

Courbe d'hydrates à composition finale locale : curve of hydrates at local final composition.